ASRS Directline

Issue Number 4

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ASRS Directline

June 1993 4

This issue of *ASRS Directline*, in addition to the normal complement of articles directed to operational audiences, contains a detailed examination of the current TCAS II implementation and a review of ASRS Database statistical data. We hope that you are able to make effective use of this information. As with all CALLBACK and *Directline* materials, we encourage editorial use, reproduction, and distribution of the articles and information contained within these pages — we merely ask that you give credit to the ASRS and to the authors, and if possible, that you send us a copy of your publication so that we may evaluate the effectiveness and usefulness of our efforts.
Here are the subjects of the fourth issue of *ASRS Directline*.

Comments or questions concerning information contained within may be directed to the ASRS at P.O. Box 189, Moffett Field, CA 94035. That does it for this issue of *ASRS Directline*
Charles Drew, *ASRS Directline* Editor

Genie Out Of The Bottle?

by Vincent J. Mellone

The upsurge in TCAS incident reporting to the ASRS points to a growing controversy between flight crews and air traffic controllers. While flight crews appear to whole-heartedly endorse its use, others, specifically air traffic controllers, feel that the difficulties and teething problems of this new technology may mean that the genie is out of the bottle — and out of control.

Background for TCAS II

Since 1955, the aviation community has strug-gled to conceive and implement an automated airborne collision avoidance system as a backup to the air traffic control system. In 1981, Administrator J. Lynn Helms committed the resources of the Federal Aviation Administration (FAA) to the development of an airborne system by 1985. Based on 1987 congressional legislation, the FAA mandated the installation of Traffic Alert and Collision Avoidance System (TCAS II) equipment on all airliners by the end of 1993. To date, approximately 70 percent of the air carrier fleet and over 400 business aircraft are TCAS II equipped. Two thousand TCAS II aircraft have flown over 2.5 million revenue miles protected by a technology that is generating discussion and even controversy among pilots and controllers .

ASRS Takes a Look

On July 29, 1992, at the request of the FAA's Office of Aviation Safety and the National Transportation Safety Board (NTSB), the ASRS provided an analysis of TCAS II incident reports. A random sampling of 170 TCAS II incident reports were coded and analyzed by a team of ASRS pilot and controller analysts in a Quick Response (QR) effort. An ASRS QR is an intensive, time-limited analysis of ASRS incident data. Although lacking some of the features of a more traditional research effort, QRs are capable of providing a useful and quantifiable "snapshot" of topical issues. This analysis made the overall assessment that TCAS II has definitely enhanced safety, but still has a number of technical and human-machine interface problems.

Note: As all TCAS units in current use are TCAS II systems, TCAS and TCAS II are used synonymously in this review.

TCAS II Saves

There are many incident reports where flight crews assert that TCAS "saved the day." An air carrier captain writes:

> *"On base leg…we were cleared by Center for [the] visual…Immediately after accepting the visual, Center reported pop-up traffic at 11-12 o'clock, level. I noticed an RA on the TCAS II with visual commands to pull up. After climbing 200 to 300 feet, I noticed a [light aircraft]…cross under us about 200 feet below. The alert Controller at Jacksonville Center, reinforced by the [TCAS II] RA command, …prevented a possible mid-air. TCAS works."* (ACN 213749)

And in another air carrier report…

> *"Hazy holiday weekend in Southern California (LA basin). Many, many VFR aircraft in [the] area. My crew alert for traffic. TCAS scope cluttered with traffic. On departure…climbing… [a] traffic conflict [at] 12:30, 3 miles, 500 to 1,000 feet above [was noted] on TCAS. I hoped to climb (zoom) above it as soon as it was acquired visually. However, it was not acquired visually until after evasive action was taken based on TCAS II RA and ATC traffic advisory. TCAS and ATC saved the day."* (ACN 179784)

This is the good news about TCAS, but these benefits have not been gained without some side-effects.

TCAS II: Issues and Incidents

Most TCAS II issues reported to the ASRS encompass anomalous or erroneous operation of TCAS II equipment, TCAS-induced distraction, airborne conflicts provoked by TCAS, and non-standard use of TCAS.

TCAS II Equipment Issues

Early versions of TCAS II equipment displayed some hardware and software anomalies. The reliability of TCAS equipment has improved considerably, but there continue to be some problems — as this recent report illustrates. An air carrier flight crew departed an airport at night in mixed meteorological conditions. With high terrain very near, they experienced a very frightening situation:

> *"Climbing through 1,200 feet [on departure] we had a TCAS II Resolution Advisory (RA) and a command to descend at maximum rate (1,500 to 2,000 feet per minute). [The flight crew followed the RA and began a descent.] At 500 feet AGL we leveled off, the TCAS II still saying to descend at maximum rate. With high terrain approaching, we started a maximum rate climb. TCAS II showed a Traffic Advisory (TA) without an altitude ahead of us, and an RA [at] plus 200 feet behind us…Had we followed the TCAS directions we would definitely have crashed. If the weather had been low IFR, I feel we would have crashed following the TCAS II directions. At one point we had TCAS II saying 'Descend Maximum Rate,' and the GPWS (Ground Proximity Warning System) saying 'Pull Up, Pull Up.' [The] ATC [Controller] said he showed no traffic conflict at any time."* (ACN 201637)

Erroneous Mode C

Controllers obtain altitude information about traffic displayed on their radar from the Mode C function of the aircraft's radar transponder. If Mode C provides erroneous altitude information, the controller will see an incorrect altitude displayed on the scope. Should a controller note a disparity between displayed and assigned altitude, he/she will ask the flight to confirm its altitude, and may request that the flight crew reset their transponder, use a different transponder, or disable Mode C.

Like a controller, TCAS II uses Mode C information to determine vertical separation on other traffic. Should Mode C even temporarily provide erroneous altitude information, an erroneous Resolution Advisory command to climb or descend may result. Unlike a controller, TCAS II cannot query the flight crew to determine if the problem lies with malfunctioning equipment. Note the following pilot report:

> *"Our flight [air carrier X]…was at flight level 260…We observed a TCAS II advisory [TA] of traffic at 12 o'clock, 1,000 feet above at about 15 miles on an opposing heading. Shortly after, we observed traffic on [the] TCAS II display descend from 1,000 feet above to 500 feet above. TCAS II commanded a descent of at least 2,000 feet per minute to avoid traffic.*
>
> *"We queried…[ATC about the] traffic. They told us we had an air carrier jet (Y) 1,000 feet below us on a converging heading.… At about the same time we visually acquired air carrier (Y) about 500 to 1,000 feet below our altitude. [The] Controller confirmed he was assigned flight level 250. We observed no traffic above, nor did the Controller have any traffic above us. Our TCAS II continued to command a descent and continued to show…[a] traffic conflict 500 feet above us. [The] Controller advised that air carrier (Y)'s Mode C did momentarily show 26,500 feet and then returned to flight level 250 on their scope. We had altered course slightly to the right to offset [the] conflict, but did not follow the TCAS II RA. If we had followed the TCAS II RA we, in my opinion, would have impacted the opposing aircraft."*
> (ACN 210599)

The First Officer of the other aircraft (air carrier Y) writes:

> *"…[Center] called traffic at 12 o'clock about 12 miles at 26,000 feet. I…spotted traffic about 7 to 8 miles out. Then we heard the air carrier jet (X) report a TCAS advisory saying the guy was showing 500 feet above them. Our aircraft was not TCAS II equipped. I continued to observe our traffic as he passed over us and in a slight right-hand bank. He appeared closer than the standard 1,000 feet separation. ATC then told us our Mode C showed 26,500 feet. The Captain and I both verified 29.92 [QNE] and 25,000 feet on our altimeters…we were at 25,000 with a faulty Mode C (which pilots have no way of monitoring). This could have been a potentially fatal situation had it not been visual [and daylight] conditions."* (ACN 210600)

TCAS II — Genie Out Of The Bottle?

TCAS II Distraction

Pilots frequently cite TCAS II related auditory and workload interference with normal cockpit duties, as is noted in the following report from an air carrier First Officer.

> *"…we received two TCAS II-advisories, corresponding to departures. The departures are cleared to 10,000 feet, [and] arrivals…[at] 11,000 feet. The TCAS II reacted to the closure rate of the departing aircraft and our inbound flight. [The] RA was ignored as traffic was in sight. The real problem is that the TCAS II alert caused such a distraction in the cockpit that two or more radio calls from Approach Control were missed."* (ACN 203411)

Non-Standard Use of TCAS II

Some pilots are using TCAS displays to maintain "visual" separation. Consider the following controller report:

> *"I was training a developmental [controller] on Arrival Control. We had an air taxi (X) for sequence to visual approach Runway 15. The developmental pointed out aircraft (Y) [to air taxi (X)] and the pilot responded, 'Is he following someone out there at 800 feet? ' The developmental was going to clear him for the visual approach when I stopped him and asked [the pilot of air taxi (X)]…if he had aircraft (Y) in sight. He said not visually, but had him on TCAS II. This seems to be happening more and more…It appears [that pilots]…are using TCAS II instead of looking out the window. As an air traffic controller I cannot have pilots using TCAS for visual separation to maintain spacing (as on one occurrence a crew offered to do). There is no TCAS II separation."* (ACN 202301)

TCAS II-Induced Conflicts

Many TCAS incident reports received at the ASRS allege that pilot response to erroneous TCAS commands has promoted a conflict where, initially, none existed. Consider the following near mid-air collision (NMAC) where the TCAS II RA may well have been triggered by the high climb rate of air carrier (Y).

A Controller's Dilemma

> *"Air carrier (X) was inbound on the…STAR level at 10,000 feet. Under my control, air carrier (Y) departed…on the…SID, climbing to [an] assigned altitude of 9,000 feet. Approximately 14 miles SW…I issued traffic to air carrier (X) that air carrier (Y) was leveling at 9,000. Air carrier (X) responded after a few seconds that they were descending. I again told air carrier (X) to maintain 10,000 feet. Air carrier (X) responded 'OK, we've got an alert saying go down.'*
>
> *"Simultaneously, air carrier (Y) was getting an alert to climb. They both followed the TCAS II [RAs] and almost collided. Later, [the pilot of air carrier (X)]…indicated [that] his TCAS II was showing zero separation. They passed in the clouds without seeing each other. When pilots start taking evasive action, our equipment cannot update quickly enough for the controller to help. Both aircraft were issued traffic as prescribed by our handbook (merging target procedures). [Air carrier] Company directives, I'm told, dictate that pilots must respond/follow the TCAS II alert advisories."* (ACN 224796)

The Captain of Air Carrier (X)

> *"[We] air carrier (X) received a Traffic Advisory [TA] annunciation followed by [an] immediate RA annunciation…'Descend Crossing Descend.' We immediately pushed over following the RA to 2,000 to 2,500 foot per minute descent. Intruder was showing 12 to 12:30, 800 feet below [and] climbing. I instructed the First Officer to advise ATC of [the] descent. ATC advised [the] intruder was [an] air carrier who was on a different frequency…and that he was leveling off. [The] Controller advised us to level and then climb. Both aircraft passed to each others' right on the same altitude. During the event things got confusing. [The] RA called for descent and then increased descent. ATC is calling for a level-off followed by an immediate climb."* (ACN 224912)

The Controller of Air Carrier(Y) Writes…

> *"[A] pilot can now disregard ATC instructions based on TCAS II alerts, even if the controller has issued traffic to that aircraft and has applied the correct separation."* (ACN 224982)

Pilot/Controller Conflict

In a recent congressional subcommittee hearing on TCAS II, Air Line Pilots Association (ALPA) President, J. Randolph Babbitt, testified, "Line pilots have strongly endorsed TCAS II and would emphatically resist any efforts to reduce its operational effectiveness." The National Air Traffic Controllers Association (NATCA) President, Barry Krasner, countered at the same hearing that "...TCAS [II] is highly disruptive to the air traffic control environment." The U.S. Government's General Accounting Office, in a summary of TCAS II surveys, detected that controllers have strong "negative" feelings while there is widespread pilot acceptance of TCAS II.

The pilot community, particularly ALPA, sees TCAS II as a "...last ditch, they-may-have-hit-if-something-is-not-done, piece of equipment..." that gives the pilot a precious way out if "...the ATC system has somehow unaccountably failed." Both the FAA and the airlines exhort TCAS II equipped flight crews to "...follow the RA..." when it is contrary to ATC instructions. In contrast, NATCA's Krasner ominously warns that TCAS II "...is an airborne system that works improperly and actually erodes an already precarious margin of safety in the skies." NATCA favors a moratorium on further TCAS II installations and calls for restricting alerts to TAs only. ALPA recognizes that TCAS II is not without its technical faults, but considers its enhanced safety value well worth the "growing pains." The issue appears to be settling down to two strongly different viewpoints: 1) NATCA wants the decision to separate aircraft to remain in the hands of the air traffic controller "...who has verified information to provide required separation;" 2) The pilot community wants an independent airborne collision avoidance system that leaves the decision for last-minute collision separation action in the cockpit.

The majority of TCAS II reports being received at the ASRS are favorable to the technology. According to on-the-scene reporters, TCAS II has prevented numerous near-midair collision situations and averted potential air disasters. However, there is growing friction between flight crews in compliance with TCAS II RAs and wary air traffic controllers. TCAS II is a developing challenge for both constituencies.

A sampling of excerpts from contrasting ASRS reports underscores the frictional issues:

- *"We were level at FL230...RA sounded with command to descend...alert ended at 22,400 feet...Center later admonished us for descending... traffic level at FL240...we listened to our TCAS RA."* (ACN 205812)
- *"ATC took offense to TCAS and its use in the air traffic system…. ATC is not too fond of TCAS because it takes away their authority."* (ACN 206966)
- *"Pilots should question TCAS II traffic if they're concerned, rather than 'doing their own thing.'"* (ACN 195990)

The optimal blending of TCAS II within the National Airspace System is expressed in the following ASRS excerpt:

- *"Both the controller and [we] were pleased with how well TCAS aided in the situation. No passengers or crew were injured in the climb."* (ACN 195211)

In the interest of serving the aviation public, it behooves pilots and controllers to find an operational accommodation that masters the safety benefits of TCAS II.

TCAS II — Genie Out Of The Bottle?

TCAS II Incident Reporting

The information provided thus far in this article has been *qualitative* in nature; we will now provide a *quantitative* analysis of the 1,997 TCAS II related incident reports that have been received at the ASRS. Approximately 7 percent of these reports are from controllers, and the remaining 93 percent from pilots. As the air carrier and business aircraft fleets moved to comply with FAR 121.356, the reporting of TCAS II incidents increased significantly between 1990 and 1992 — as can be seen in Table 1.

Table 1 — TCAS Incident Records in ASRS Database

	1988	1989	1990	1991	1992	Total
TA or RA Incidents	1	3	7	646	851	1,507
Other TCAS Incidents	5	6	32	205	241	489
Total TCAS Reports	**6**	**9**	**39**	**851**	**1,092**	**1,997**

Table 2 provides the airspace involvement for all ASRS database TCAS incident records — for the aircraft of the principal reporter of an incident (primary aircraft). (Note that airspace categories are not necessarily mutually exclusive.) The single airspace category in which the majority of TCAS incidents occurred was in "Other" Controlled Airspace, meaning within controlled airspace but outside of TCAs, ARSAs, etc. The next most commonly involved airspace was in Terminal Control Areas (TCAs), while the third most common airspace category was in the Positive Control Area (above 18,000 feet).

Table 2 — Airspace Categories of ASRS Database TCAS Incident Records

Other Controlled Airspace	596
Terminal Control Area (TCA)	559
Positive Control Area (PCA)	374
ARSA	162
ATA	127
Control Zone	33
TRSA	11
Special Use Airspace	6
Uncontrolled Airspace	4
Other	400
Total Citations from 1,997 Records	**2,272**

Table 3 indicates the flight phase of ASRS database TCAS incidents. (As with airspace categories, ASRS flight phase categories are not necessarily mutually exclusive.) The flight phase most commonly cited for the primary aircraft was Cruise. Note, however, that if the climb and descent phases of flight are combined, they total 1,151 citations — 30 percent more than the cruise phase.

Table 3 — Aircraft Flight Phase of ASRS Database TCAS Incident Records

Cruise	876
Descent	624
Climb	527
Approach	482
Maneuver	66
Go-Around	51
Takeoff	40
Missed Approach	17
Total Citations from 1,997 Records	**2,683**

Quick Response Data Set

Now lets look at the 170 randomly selected records that comprised the QR data set. There were 159 incident reports by pilots, and 11 controller reports. In 153 of 170 incidents, flight crews received *both* a TCAS II TA and RA. For those 153 records, Figure 1 shows what pilot avoidance action was based on. Note that in the majority of incidents, avoidance action was based on the RA.

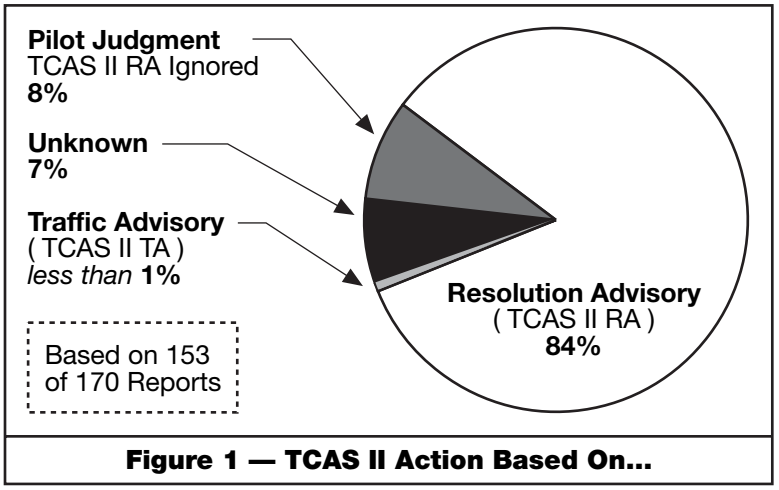

Figure 1 — TCAS II Action Based On...

In 111 of 170 incidents, the reporter provided information about visual acquisition of their TCAS II targets. Figure 2 shows when and if traffic was acquired visually by the flight crew. In 68 percent of incidents, the flight crew never sighted their traffic.

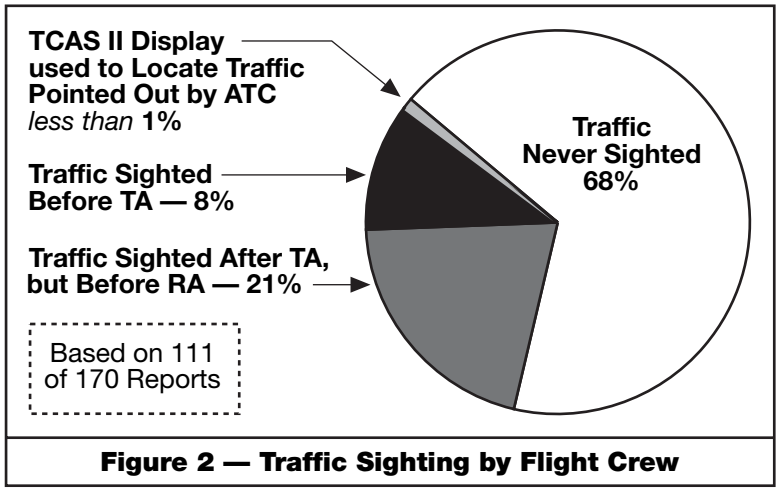

Figure 2 — Traffic Sighting by Flight Crew

Figure 3 shows whether or not ATC observed the TCAS II traffic for the entire 170-report QR data set. In the majority of instances, ATC did "see" the traffic.

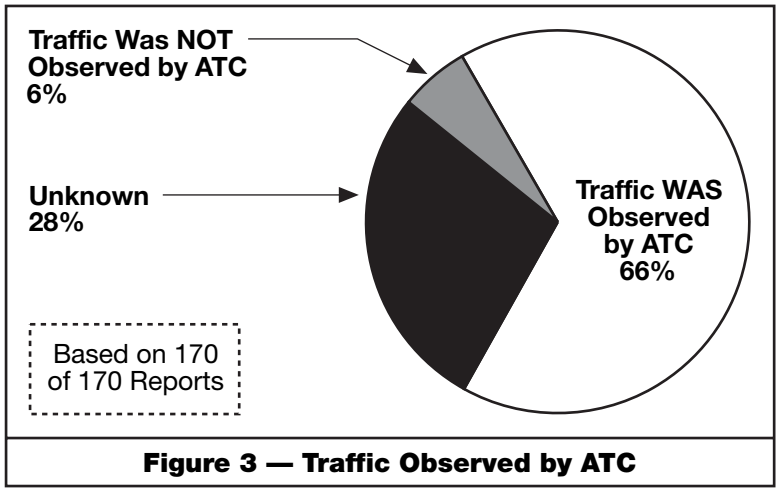

Figure 3 — Traffic Observed by ATC

TCAS II — Genie Out Of The Bottle?

Figure 4 indicates that ATC provided traffic advisories in 136 of 170 TCAS II incidents. There were 34 instances in which ATC response to a potential conflict was unknown. According to reporters, ATC ***did not*** provide a traffic advisory in 48 of 136 TCAS II incidents (35 percent).

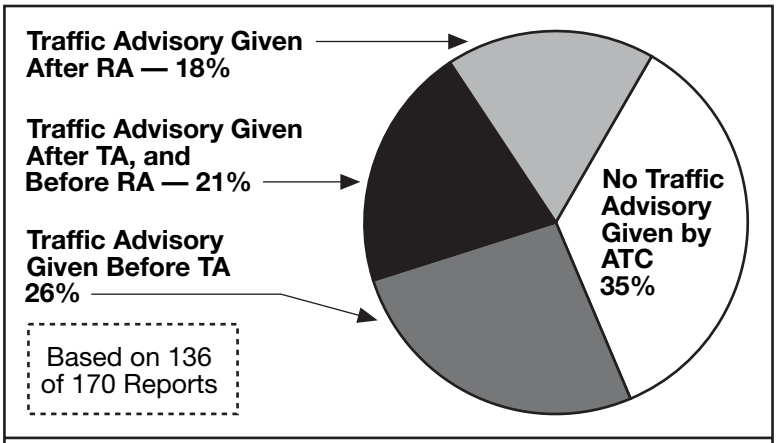

Figure 4 — Traffic Advisories Issued by ATC

Table 4 shows how reporters felt about TCAS II. Reporters could express more than a single opinion; thus there are 301 individual responses (citations) from 170 reports. In 94 instances, the reporter stated or implied that TCAS enhanced safety. This table provides the key findings of the Quick Response analysis effort, indicating that reporters in the 170-record QR data set strongly endorse the safety value of TCAS II. However, this finding is undoubtedly influenced by the relatively large percentage of these reports that come from pilots rather than controllers.

Table 4 — TCAS II "Quick Response" Key Findings	
TCAS II enhanced safety	94
TCAS II "saved the day"	55
TCAS II assisted in visual sighting of intruder aircraft	52
TCAS II prevented an NMAC (near mid-air collision)	47
TCAS II derogated safety	27
TCAS II increased workload	7
TCAS II prevented an airborne conflict/less severe	7
TCAS II caused a loss of standard separation	6
TCAS II display is too cluttered or distracting	6
Total Citations from 170 "QR" Reports	**301**

Recommendations

The ASRS analyst staff are certainly no wiser than those in government and industry who are grappling with TCAS II issues, nor would we make suggestions that conflict with TCAS II standard operating procedures. Nonetheless, review of TCAS II incident reports does suggest that there may be ways to deal with, or even avoid a TCAS incident.

Controllers

- High **rates** of climb and descent, particularly in auto-flight aircraft, are often implicated in erroneous TCAS II activation. Controllers should be alert to the possibility of a TCAS II RA for an aircraft while it is in its final 1,000 feet of climb or descent and in proximity of traffic.
- Providing traffic advisories in a timely manner to TCAS-equipped aircraft in climb and descent in the terminal area, even though separation has been previously established, may help reduce the number or severity of TCAS events.
- Controllers must remember that both FAA and company TCAS II instructions stress pilot compliance with RA commands. Venting anger or annoyance at pilots can heighten tensions and promote distraction.

Pilots

- As with any technology, TCAS II is not foolproof. Be alert for anomalous operation of the unit, particularly in proximity to terrain.
- TCAS incidents are most likely to occur in the climb and descent phases of flight. It is recommended that flight crews, where possible, reduce vertical rates when closing on target altitudes to those recommended in the Airman's Information Manual (AIM). Auto-flight aircraft with programmed high rates of vertical speed may be particularly prone to erroneous TCAS "triggering."
- Alerting ATC prior to or concurrent with executing your RA response, whenever cockpit workload and frequency congestion permit, could help controllers reduce the impact of the avoidance maneuver on other traffic in the area.
- TCAS II works well at providing separation in conflict situations. In a number of instances where pilot response to TCAS RAs has been delayed or tentative, close air-misses have resulted. This suggests that, once the flight crew has decided to respond to a TCAS II alert, their response should be immediate and complete.
- Excessive responses to TCAS II alerts have also caused many problems. It is suggested that pilots limit their response to RAs to that commanded by their TCAS II equipment. Exceeding TCAS II vertical commands into the next cardinal altitude could provoke an unintended near miss or loss of separation with other traffic.

Summary

TCAS II, in the opinion of much of the pilot community, has been instrumental in reducing risks associated with airborne conflicts. Many in the ATC community, however, feel that TCAS II has increased workload and derogated the primary responsibility of the air traffic controller — that of providing traffic separation. These sharp divisions between the pilot and controller constituencies, with resulting friction, may, if not adequately managed, result in an overall negative impact on flight safety. For some controllers, it is inconceivable that ATC should not be "in-the-loop" prior to or during TCAS activation. As industry and government grapple with TCAS problems and issues, it is important for pilots and controllers to jointly understand and manage the TCAS environment — so that the genie remains under control.

The Unexpected Results of... The "Expect" Clearance Technique

by Don George

I'm getting ready for another flight on an air carrier, and these somber events never fail to generate a lot of thought about some of the problems in our National Airspace System. I am somewhat familiar with these problems because I've been involved with the analysis of incident reports submitted to the NASA Aviation Safety Reporting System (ASRS) over the past sixteen years, and I'm happy to say that you folks, the users of the airspace, do a fine job of keeping ASRS apprised of the types of problems being encountered.

For this upcoming flight I will once again be acting as PIC on a non-stop (hopefully), coast-to-coast wide-body aircraft. PIC, in my case, means either *Passenger in Coach*, or *Prisoner in Coach*, depending upon my attitude of the day. I take the responsibilities of PIC very seriously and always start flight planning several weeks, or sometimes months, in advance. Part of the preflight planning includes the selection of a "Primary Worry of the Day," along with several secondary or alternate problems to worry about. For this trip I have chosen the subject of "expect" clearances as the primary.

Most pilots and controllers are familiar with the term *expect clearance*, but it seems to me that the term is a real misnomer, because what is referred to as *expect clearance* is **not** an Air Traffic Control (ATC) clearance at all, and should never be thought of as an authorization to do something — except in some rare cases of loss of radio communication.

For the remainder of this article I will try very hard to refrain from putting the words *expect* and *clearance* together in that order; *expect* should not be used as an adjective to describe a type of clearance. Okay, I *expect* you get the idea.

When used in the proper circumstances, expressed correctly by the controller and understood by the pilots, the ATC technique of telling the pilots what to expect is a very good method for making the ATC system work better and for easing both cockpit and controller workload. The word *expect* is one of the planning tools which controllers can use very effectively to smooth out the flow of air traffic. However, as with most tools, there are some precautions which perhaps should be "printed on the container," or in some manner brought to the attention of the users.

This article is an attempt to provide some of those cautions, and also to offer some suggestions to make the "expect" technique safer and more effective.

Background

Once upon a time, on a dark and stormy night, in an effort to assist pilots and controllers in their planning, the phraseology "...Expect altitude XXX, or Flight Level XXX in YY minutes/miles..." was introduced into the Controllers Handbook (ATP 7110.65). The intent was to allow the pilot to better plan climb/descent profiles. Although well intended, this practice contributed to a large number of altitude deviations.

The climb/descent phases of flight are quite busy times in the life of a flight crew, and the work load in a single-pilot cockpit may be even more critical. During those times when cockpit duties require that one pilot is responsible for flying, communicating, and possibly configuring the aircraft for climb or descent, it is easy for the pilot to misunderstand an instruction to *expect* an altitude change. Further, these phases of flight usually occur in airspace where controllers are often very busy, and the potential seriousness of the problem is increased if the controller fails to detect an error in the readback — a traffic conflict may well be the result.

Whenever a pilot requests an altitude change, or if the controller wishes to alert the pilot that a new altitude assignment will be forthcoming, the controller often uses the terminology, "Expect [specific altitude] in XX minutes/in YY miles/ at [fix]/after passing [traffic], or *after* [meeting some other condition]."

The ASRS database contains many reports of pilots misinterpreting this type of transmission as being a clearance to climb/ descend to the specific altitude mentioned.

The problem has been alleviated to some degree by a change in the ATP 7110.65 Handbook. Paragraph 4-46 now enables the controller to inform an aircraft when to expect climb or descent clearance without stating a specific altitude. The phraseology now reads, "EXPECT HIGHER/LOWER ALTITUDE IN (numbers of miles or minutes) MILES/ MINUTES." Nonetheless, "expect" type deviations continue to occur because some controllers are not aware of, or have forgotten it.

Expect-actions

I have always preached that controllers should not mention an altitude to a pilot unless they want the pilot to go there, so I believe that this newer handbook phraseology is a big step in the right direction, and should decrease the number of altitude deviations. However, in addition to the climb/descent phases of flight, the "expect" technique is used in conjunction with all sorts of down-line planning. Some common examples include: expect vectors; expect visual approach; expect ILS Runway two-seven; expect departure after two more landings; expect no delay; expect (altitude) ten minutes after departure; expect to hold at; and the list goes on and on.

In addition to the ***verbal*** transmissions of what pilots may expect, there are also ***visual*** "transmissions" placed on charts for planning purposes. Standard Terminal Arrivals (STARs) and Standard Instrument Departures (SIDs) very often include expected altitudes, expected course guidance, expected speeds, etc. Here again, remember that the printing of those **expect values on the charts does not constitute an ATC clearance to descend, climb, turn, etc**. If the chart says expect, the pilot still needs a specific clearance from the controller before the action is authorized. **However, when the altitudes, routes, speeds, etc., are printed *without* the word expect, they are mandatory**. Profile descent procedures contain good examples of these mandatory crossing altitudes and tracks to be flown, and do not seem to cause nearly as many problems as do the STARs and SIDs. Probably the STARs/SIDs are more often confused because they may contain both mandatory and expect values.

All of this sounds pretty straight forward and fairly uncomplicated, so. . . . .

What are the Problems?

Well, reports to the ASRS reflect a variety of incident types in which there was an unexpected action resulting from the use of the "expect" technique. In the preparation of this article I started with several hundred such reports in front of me, and after reading them several times, I have picked a few which may provide you with some insight into the kinds of problems being encountered — kind of like trying to pick the best six or seven chunks of apple from a barrel of fruit salad.

Learning from other peoples' mistakes sure beats the heck out of making your own errors, so it should prove to be beneficial for you to read, interpret and analyze the following reports submitted to ASRS. I suggest that you take the report narratives one at a time, and try to figure out what happened, why it happened, and what, if anything, should have been done differently to prevent the occurrence. Compare your analysis to ours.

The Unexpected Results of...
"Expect" Clearance Technique

Situation #1

Altitude Deviation
Less Than Standard Separation:

"…[Air carrier] X west bound through my sector at flight level 370 and…[light transport] Y on the FEVER 2 STAR to SDL... Y was issued a descent to flight level 390 and the pilot asked if the descent was at his discretion. I told him affirmative, however to expect to cross FEVER Intersection at 11,000 [feet] and 250K. The…[flight crew] misunderstood my expect for a clearance and started descent, …[and passed through flight level 390] resulting in a loss of separation."

Supplemental Information from ACN 127770:

"[Air carrier] X noticed an aircraft on descent through our altitude in front of us…Y was in a rapid rate of descent. ATC indicated…Y was descending into Scottsdale, and was cleared to descend from flight level 450 to flight level 390 and to expect further descent."
(ACN 128222, 127770)

★ Analysis

If the Controller had delayed any mention of 11,000 feet until the aircraft had passed each other, there probably would have been no incident to report.

Situation # 2

Speed Deviation:

"Both the Copilot and I misread the GLAND SIX Arrival chart as 'expect clearance to cross GLAND at 10,000 feet and 250 knots.' Actually, it said 'Cross GLAND at 250 knots, expect clearance to cross at 10,000 feet.' When we were cleared to cross GLAND at 10,000 feet, we discussed the clearance and decided that, since the Controller did not give a speed restriction, none was required. We were [then] switched from Center to Approach at GLAND. The [Approach] Controller asked our airspeed and we told him it was 290 knots. He said it should have been 250 knots, since that was a 'mandatory,' not an 'expect,' restriction. He said the slower speed was important for vectoring onto the approach. It is difficult to read small print on approach charts. Pilots anticipate mandatory restrictions only on profile descent charts. You see what you ***expect*** *to see. Speed restriction [was] not given by [the] Controller when 10,000 foot altitude restriction given, since it was on the chart. I recommend an underline, shadow, or some other highlight for mandatory altitude or airspeed restrictions on non-profile charts. Controllers should restate mandatory airspeed restrictions when altitude restriction is transmitted."* [Emphasis added]
(ACN 137454)

★ Analysis

The STAR Chart for this arrival has an *expect* crossing altitude, but airspeed is mandatory — not an uncommon situation. Perhaps the flight crew did not adequately brief the descent and approach.

Situation # 3

Altitude Deviation
Potential traffic conflict:

"Positioned north of airport and heading approximately 230 degrees, on approach to…6R. Controller asked if we could accept visual to 6R. We accepted and were told to descend to 4000 feet (on current heading) and to report runway in sight. I called runway in sight out of 5000 feet while approaching 4000 feet; however, the radio call was delayed due to another transmission from Approach. Continuing descent, at about 3300 feet, we told Approach we had the runway as the frequency became clear. The Controller advised [to] maintain 4000 feet, climb back to 4000 feet, which we did. It became known to me then that we had not been cleared for the visual as I had thought."

Supplemental Information from ACN 133419

"…Approach said, 'Cleared to 4000 feet, expect visual, report runway in sight.' I called out 4000 feet, as I could see we had a sink rate. At 3800 feet, Captain had gear down, flaps 5 degrees…and I said, 'We're cleared to 4000 feet'…Approach said, 'I show you at 3800 feet, check altimeter 29.69. You have traffic at 3000 feet.' We continued descent to 3500 feet. I told [the] Captain, 'We're at 3500 feet, we have traffic at 3000 feet, we're cleared to 4000 feet.' He said, 'Tell them we have the runway in sight for a visual.' When I told [the] Controller we had runway in sight, he said, 'You have traffic at 3000 feet, climb immediately to 4000 feet.' I said, 'We're at 3300 feet, climbing to 4000 feet.' We then climbed to 4000 feet and had a normal approach and landing."
(ACN 133416, 133419)

★ Analysis

One-half of the flight crew understood that the message was an "expect" advisory. Unfortunately, the other half was flying. Better crew coordination and cockpit management was needed here.

Situation # 4

Runway Transgression:

*"While holding short of Runway 17R at DFW, The Tower Controller was busy. Both the First Officer and I understood him to say position and hold behind…air carrier [X]. He was extremely busy giving continuous run-on instructions with no gap to allow for acknowledgments. After I taxied into position, the Tower Controller said, '**Now** you are cleared into position and hold — I told you to **expect** position and hold behind…air carrier [X].' We stated we heard we were cleared into position. He then responded with 'I'll pull the tape.' Regardless of who was correct here, this was a prime example of poor communication…the clearance was ambiguous and obviously easy to misinterpret."* [Emphasis added]
(ACN 179906)

★ Analysis

During an extremely busy traffic situation, the Controller was trying to keep things moving expeditiously by advising this flight crew of what to expect. However, the flight crew misunderstood the planning advisory to be an actual clearance into position on the runway. Perhaps the use of "Expect Technique" was unnecessary in this situation, and was a contributing factor in the runway incursion incident.

Some of the other factors were: frequency congestion, traffic volume, controller ATC technique, controller radio communication technique, and flight crew anticipation and perception.

Situation # 5

Altitude Deviation:

"The First Officer was flying the aircraft. We normally cruise at 18,000 feet on this route, but due to winds aloft and weather conditions, we decided on 12,000 feet for a final cruise altitude. We were handed off to…Center while climbing through approximately 5000 feet. After checking in, our clearance was to 11,000 feet and we were told to 'expect 12,000 feet.' Climbing at roughly 1200 feet per minute, I (the PNF) selected 11,000 feet on the altitude alerter. Through 10,000 feet I performed the '10,000 / Climbing' checklist and began to activate our anti-ice equipment, as we were entering an area of probable icing. Upon level-off, I noticed we were at 12,000 feet, and not 11,000 feet. As I was about to inform [the] Center [Controller], he called and cleared us to 12,000 feet. I acknowledged and nothing was said about the matter between us and [the] Center. I looked at the altitude alerter and discovered that it had been reset to 12,000 feet by the First Officer (who was also flying the airplane). I explained to him that we were told to 'expect' 12,000 feet and that we were only cleared to 11,000 feet, which is why I set the altitude alerter to 11,000 feet. He told me that he thought we were cleared to 12,000 feet and (since I was busy with the checklists and anti-ice equipment) he reset the alerter to 12,000 feet. Our 1000 foot deviation was the result." (ACN 164511)

★ Analysis

There was a breakdown in cockpit coordination. Additionally, the Controller could have said "Expect higher," instead of "Expect 12,000 feet." Hope the reporter gets a chance to read this article.

Space doesn't permit, but I wish that we could have included more ASRS report narratives because, as previously stated, there are important lessons to be learned from other folks' misadventures.

Factors

Communications

A communication error is the most frequently cited problem element of incidents reported to ASRS, and you probably noted that some type of communication problem played a role in each of the "expect" incidents presented in this article.

Communication problems take a variety of forms. Equipment deficiencies, phraseology, similar callsigns, speech rate, blocked transmissions, and failure of the readback/hearback process are just a few types of communications problems. The subject is too broad to be covered to any great degree in this article, but I do want to make the point that communication problems often lead to a "Flawed Information Transfer" (FIT), and if the flawed information is not corrected soon enough, the result may be an "Occasional Semi-Hysterical Information Transfer" (acronym unknown).

Other Factors

In addition to communications factors, there are other factors which contribute to "expect" incidents. Some are: pilot/controller training in progress, pilot/controller experience level, pilot/controller distractions, pilot/controller work load, weather, fatigue, schedule pressures, cockpit coordination/management, controller planning/technique, charts/publications, traffic volume, etc.

Summary

The Problem

Sometimes very unexpected and undesirable actions are taken by pilots after they have received an "expect" transmission from a controller, or after misinterpreting some "expect" information printed on a chart. The intended transfer of information (verbal or visual) may be misheard, misunderstood, mis-stated, misread, misinterpreted, or simply missed.

The Cure

Controllers

- Avoid, whenever feasible, issuing specific values (such as altitudes or airspeeds), by instead transmitting phrases like "expect higher altitude," "expect turn shortly," "expect speed reduction prior to (fix)," etc.
- When using your "expect" technique, try putting a lot of emphasis on the word "**expect**."
- Use your "expect" technique in a timely manner (timing is important). For example, it is probably not a good idea to mention an expect altitude at the same time that two aircraft with minimum vertical separation are about to pass each other.
- Establish a good hearback habit so that flawed information transfer can be corrected during the readback/hearback process — before an incident occurs.

Pilots

- When a controller or a chart says to "expect" something, it means that there is a tentative plan in place, but the pilot should **NOT** take action until receiving a specific ATC clearance. Keep in mind that the actual clearance may be different from what you had been told to expect because the air traffic situation has changed.
- Try to give a precise readback as soon as frequency availability permits; always report leaving a previously assigned altitude. Even better, any time an altitude change is about to be made, the pilot should advise ATC of the altitude that is being vacated as well as the intended (target) altitude. For example, aircraft XYZ has just been cleared to descend from flight level 220 to 11,000 feet. Good technique would be for the flight crew to call ATC prior to initiating the descent, saying *"ABC (Center), XYZ leaving flight level two-two-zero for one-one thousand, that's eleven thousand."*

Pilots *and* Controllers

- Work to enhance radio communication skills. Adopt the policy of not accepting doubtful messages, and ask for clarification or repeat of any unclear transmissions. Check technique for clear, concise phraseology and acceptable speech rates.
- Be alert to the possibility of other contributing factors being present. While these other factors may not be directly controllable, it should help if we are aware of the fact that they may be affecting our performance at any given time, and that we must take precautionary steps to minimize their effects. For example, when the flight crew fatigue factor is present, and the flight crew is in a "hurry-up" mode due to schedule pressure — it is time to take a deep breath and a few extra seconds to check, and then recheck.

THE STERILE COCKPIT

by Robert L. Sumwalt

It's no secret. When a flight crew's attention is diverted from the task of flying, the chance of error increases. Over the years there have been dozens of air carrier accidents that occurred when the crew diverted attention from the task at hand and became occupied with items totally unrelated to flying. Consequently, important things were missed. Things like setting the flaps prior to takeoff, or extending the landing gear before landing. Things like monitoring altitude on an instrument approach, or using engine anti-ice for takeoff during a blinding snow storm.

In 1981 the FAA enacted FAR 121.542 and FAR 135.100 to help curb the number of these accidents. Commonly known as the "sterile cockpit rule," these regulations specifically prohibit crew member performance of non-essential duties or activities while the aircraft is involved in taxi, takeoff, landing, and all other flight operations conducted below 10,000 feet MSL, except cruise flight. (See the box for FAR 121.542 and 135.100 on Page 19.)

It's unrealistic to expect a crew to fly together for several days and never discuss anything except items related to flying the aircraft. In fact, experts have demonstrated that in order to be most effective, crews need to talk — even if it is just merely "get to know you" sort of chat. The sterile cockpit rule is a good rule because it clearly defines when it is time to set aside non-essential activities and tend strictly to the task at hand — that of safely operating the aircraft.

In spite of the existence of the sterile cockpit rule over the past decade, pilots have continued to have accidents and serious incidents that perhaps could have been prevented. For the most part, disobeying the rule is not intentional. It just happens. But as this review shows, the consequences of non-compliance can be very serious. Truly, the sterile cockpit needs to be cleaned up.

This reviewer used the ASRS database to find specific examples of problems related to non-compliance with the sterile cockpit rule. We carefully reviewed 63 reports that had been previously coded by analysts as having some relevance to the sterile cockpit rule. Here is a synopsis of the problems that we found that could be attributed to sterile cockpit violations:

- 48% were altitude deviations
- 14% were course deviations
- 14% were runway transgressions
- 14% were general distractions with no specific adverse consequences
- 8% involved takeoffs or landings without clearance
- 2% involved near mid-air collisions due to inattention and distractions.

The Culprits

The way in which the sterile cockpit rule was broken in each report was tallied and analyzed. Some reports contained more than one culprit. Many of the reports contained acknowledgments like this:

> *"If we [had] adhered to the sterile cockpit, this situation probably would not have occurred."* (ACN 118974)

Following are the four most common reasons for non-adherence to the sterile cockpit rule:

Extraneous Conversation

The most habitually cited offense was extraneous conversation between cockpit crew members. Cited one First Officer:

> *"Although VMC on the approach, the new special weather was… [indefinite ceiling, 200 obscured, visibility 1-1/4 mile in ground fog], snow falling and some snow on the runway...I was flying and Captain viewing PIT stadium and various sights out the window, chatting incessantly...Captain then reviewed procedures for short ground roll on snow covered runways and returned to miscellaneous conversation."* The crew believed that they then landed without contacting the tower and receiving landing clearance. After some serious soul searching, this reporter continued *"...the potential for disaster scenarios should be apparent...The bottom line: lack of professionalism. Captain habitually rambled from push back to block-in through a four day trip. This was the first of two incidents on the same day...Below the line: lack of courage. F/O and F/E were not willing to ask the Captain to please shut up so we could fly the airplane."* (ACN 102595)

The Captain of an air carrier aircraft admits to conversation not pertinent to flying duties:

> *"...Both the F/O and I became distracted because of a conversation that was started before the level-off. At 4300 feet our altitude alert system went off...Our sterile cockpit procedures should have eliminated this problem if properly followed."* (ACN 168474)

Five reports detailed extraneous conversation with jump seat riders. The ability to ride on an air carrier's jump seat is quite a valuable privilege, but it is important that the additional cockpit rider not be allowed to create distractions. A look at two of these reports:

> *"While descending into a broken deck of clouds, unannounced traffic appeared at 12 o'clock and less than a mile, climbing up our descent path. In my best estimation we were on a collision course. I immediately, without hesitating, instinctively pushed the aircraft nose down and to the right to avoid impact. The Captain was engaged in a conversation with [somebody] on the jump seat."* (ACN 167026)

And in the other ASRS submission:

> *"This very senior Captain was about to leave on a Scuba diving trip and talked nonstop to the female jump seat rider upon discovering she was also a diver...This [altitude deviation] could have been prevented entirely if this particular Captain…[had paid] attention to his job and observe[d] some approximation of the sterile cockpit below 10,000 feet."* (ACN 119289)

The connotation "extraneous conversation" does not always have to imply just those persons on board the aircraft. Look at how extraneous chatter with air traffic controllers introduced problems for these crews. Air traffic controllers, take notice:

> *"We turned base to final. Tower talked about mutual acquaintances and local weather. On final, at about 2500 MSL, we realized we lined up for the wrong field...First mistake: getting involved in conversation with [the] Tower operator..."* (ACN 108035)

And in another incident:

> *"At the outer marker...with thunderstorms in progress, reported wind shear and heavy rain ...the tower insisted on knowing if our gate was open. We told him we were too busy to find out, he persisted with claims of needing to know where to put us on the ground once we landed. We attempted once to try to contact the company but failed due to frequency congestion... We were distracted by the tower's request for non-pertinent info during the sterile period... This [practice]…(of the controller needing to know if a gate is open at the most intense and critical phase of flight) must not be continued. It is an unsafe practice and deters us from conducting a safe flight."* (ACN 114244)

Distractions from Flight Attendants

Distractions caused by flight attendants visiting the cockpit or calling on the interphone were noted in almost one quarter of the reports in our data set. This was our second highest source of deviation from the sterile cockpit rule.

> *"As aircraft approached Runway 18, Flight Attendant 'A' entered cockpit with coffee for the crew. Crew attention momentarily diverted...Aircraft penetrated hold line approximately six feet for Runway 18...Small single engine aircraft on final for Runway 18 was instructed to go around by Tower...Probable cause of this was short taxi distance to hold line and crew's interruption by [the] Flight Attendant."* (ACN 149054)

In another incident, the crew was surprised when they lined up with the wrong runway — and doubly surprised when they noticed they were in an unplanned formation with a jet landing on the same runway!

> *"...Flight Attendant came into the cockpit and asked what gate we were going into as we had a passenger with a wheelchair going to another flight...I advised approach we had our traffic [in sight]. Approach now cleared us for what I thought was a Runway 26L visual approach, call tower at the outer marker. As we proceeded to Runway 26L, which was the closest runway to our arrival side,..I looked over [at] my First Officer and out his side window and saw the [other jet] at our altitude, approximately 100 feet away...I'm sure that, with the Flight Attendant interruption, I heard what I expected to hear, 'cleared to the left runway.'"* (ACN 98883)

Non-Pertinent Radio Calls and PA Announcements

Several reports we examined indicate that problems arose when non-pertinent company radio calls and PA announcements were made below 10,000 feet. Remember, below 10,000 feet if it's not directly related to flight safety, it's in violation with the sterile cockpit rule.

> *"Beautiful day making approach into familiar station, Captain elects to make a PA announcement to passengers while flying the aircraft. Resulting distraction of the passenger announcement [caused us to over-shoot]… altitude 500 feet."* (ACN 54741)

While being vectored in a busy terminal area, the Captain in the following report called on the company radio frequency to notify maintenance about a minor cabin discrepancy. As the reporter soon discovered, his absence from the ATC frequency caused an overload with his First Officer. Several ATC radio calls were missed. The controller growled a little, they lost their landing sequence, and the pilot's pride was hurt. But a valuable lesson was also learned.

Cockpit Chatter Leads to Crash

From Flight Safety Foundation's August 1992 Flight Safety Digest (Accident/Incident Briefs)

DHC Dash 7. Aircraft Destroyed. Thirty-six fatalities.

The four-engine Dash 7 was on an instrument approach to Runway 04 when it crashed into high terrain about five nautical miles from the airport. At the time of the crash, the aircraft was slightly off course and flying at an altitude of 560 feet MSL (mean sea level). The published minimum altitude at the area of impact was 1,200 feet MSL.

A subsequent investigation indicated that the pilot was having a conversation with a passenger who was sitting on the jump seat. The report said the crew was likely distracted by the conversation. The report cited the pilot and copilot for poor airmanship in not monitoring altitude and course information.

"...My thinking, however irresponsible it was, was that I should call maintenance with this item to save us time on the ground...I realize that the incident and this report is the result of very poor cockpit management on my part...It was most unwise and unfair of me to put the work load I did on that Controller and the First Officer...I hope I have learned the importance of giving my undivided attention to Approach Control, as opposed to reporting maintenance items [while flying below 10,000 feet]." (ACN 92145)

Sight-seeing

Nowhere does Webster's define "sight-seeing" as an activity that is essential to the safe operation of aircraft. When sight-seeing is conducted by flight crew members below 10,000 feet, not only is it potentially dangerous, but it is illegal, as well. Two reports demonstrated that a cockpit full of sight-seeing crew members is an ASRS report looking for a place to happen — possibly even an accident.

"Assigned the PORTE SID from SFO. I missed the 4 DME turn point due to preoccupation with a [special purpose aircraft] below and to our right, landing at NAS Alameda. The Captain (flying) missed it too...Bay Departure queried us and advised us to maintain visual separation from [another aircraft] off OAK, paralleling us below and about 2 miles to the right. Preoccupation with the visual environment caused us to neglect the IFR procedure." (ACN 189397)

In another incident report:

"...Descending through 5000 feet to my assigned altitude of 4000 feet. The Captain discontinued his running commentary of the sights...to state that we were only cleared to 6000 feet." (ACN 83932)

Sterile Cockpit Rules

FAR 121.542 / FAR 135.100 Flight crew member duties

(a) No certificate holder shall require, nor may any flight crew member perform any duties during a critical phase of flight except those duties required for the safe operation of the aircraft. Duties such as company required calls made for non-safety related purposes as ordering galley supplies and confirming passenger connections, announcements made to passengers promoting the air carrier or pointing out sights of interest and filling out company payroll and related records are not required for the safe operation of the aircraft.

(b) No flight crew member may engage in, nor may any pilot in command permit, any activity during a critical phase of flight which could distract any flight crew member from the performance of his or her duties or which could interfere in any way with the proper conduct of those duties. Activities such as eating meals, engaging in non-essential conversations within the cockpit and non-essential communications between the cabin and cockpit crews, and reading publications not related to the proper conduct of the flight are not required for the safe operation of the aircraft.

(c) For the purposes of this section, critical phase of flight involves all ground operations involving taxi, takeoff and landing, and all other flight operations conducted below 10,000 feet, except cruise flight.

Note: Taxi is defined as "movement of an airplane under its own power on the surface of an airport."

Recommendations and Considerations

The sterile cockpit rule was designed to help minimize many of the problems that we just annotated. Judging from these reports, a safer operation can be achieved by simply abiding by the rule's guidelines.

In the Beginning

A good time to establish the desire to maintain a sterile cockpit environment is before beginning a trip. In briefing cockpit and cabin crew members the captain can politely say, "I think the sterile cockpit rule is really important, so we'll adhere to it. Okay?"

Setting the Standards

During the preflight briefing the captain should also inform the flight attendants how they can determine if the flight is above or below 10,000 feet. Many companies have already established procedures for this, such as a "10,000 foot PA announcement," or a call to the flight attendants on the interphone. However, these procedures require one crew member to be "out of the loop." And as evidenced by literally thousands of ASRS reports, the potential for problems (such as misunderstood clearances and altitude deviations) increases when a crew member is out of the loop. Some airlines have installed a cockpit-controlled "sterile cockpit light" that can be illuminated when descending below 10,000 feet and extinguished when climbing above 10,000 feet. For those who develop company procedures, consideration should be given to developing something that doesn't create its own set of distractions. With the increased use of two-crew member cockpits this consideration is increasingly important.

Unexpected Entry

Unexpected calls or cockpit entry by flight attendants during the sterile cockpit period can be distracting and potentially dangerous. It is recommended that the Captain, during the pre-departure crew briefing, emphasize the importance of the sterile cockpit rule and request that flight attendant calls or entry during this time be undertaken only for reasons of great urgency. As one reporter resolves:

> *"The next time a flight attendant enters a sterile cockpit, I will immediately ask if there is an emergency."* (ACN 109249)

High Altitude Airports

Another reporter offered a good suggestion involving high elevation airports, where 10,000 feet MSL for the sterile cockpit boundary may be too low.

> *"The First Officer and myself were involved in a conversation with the company pilot riding jump seat. Although I subscribe to the sterile cockpit rule below 10,000 feet, I failed to realize that, due to Denver's high field elevation, 17,000 feet MSL would have [been] a more appropriate time to discontinue our conversation and be sure that our affairs were in order...Unfortunately, because of our conversation, I failed to slow to 250 knots until passing Kiowa...The main reason I am filing this report is that I was habitually using 10,000 feet MSL for focusing my attention on the terminal/approach procedure and maintaining a sterile cockpit. A better method would certainly be 10,000 feet AGL or 40 to 50 miles from destination."* (ACN 65327)

Low Altitude Flight

This reporter, a commuter pilot who often has cruise altitudes below 10,000 feet MSL, offers a similar worthwhile suggestion following an altitude deviation.

> *"I believe this situation occurred because our cruise altitude was 8000 feet, and we were accustomed to conversation and other activities along the route and were not observing the 'sterile cockpit' environment. Would suggest that, in these flight circumstances where cruise altitude is less than 10,000 feet, crews make a specific DME mileage their beginning for 'total concentration-sterile cockpit' procedures."*
> (ACN 173707)

No person about to undergo major surgery would think too kindly of the surgical team who failed to sterilize themselves and their operating instruments before the operation. After a series of air carrier accidents and serious incidents, the traveling public feels the same way about their crew members. **Keep the sterile cockpit "clean."** Your fellow crew members and passengers are hoping that you will.